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Pollute first, clean up later?

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Abstract

There is a growing concern with regard to sustainability in emerging economies like China. The Chinese growth is characterized by a strategy which is known as “pollute first, clean up later”. Here we show that based on this strategy, the pollution alarm can often be postponed by a tremendous economic growth that can potentially improve welfare and educational systems. The welfare and educated societies will be aware and rich enough not only to clean up but also to prevent the environmental pollutions. It underlines that a certain threshold of development should first be reached before a society is capable of understanding the adverse effects of large scale pollution. For this purpose, we need to encourage the use of fossil fuels in the first place. The challenge however remains to make sure whether such a strategy can develop in a sustainable way.

Keywords: Pollution, economic growth, emerging economies, global warming, GHG, sustainability.

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1. Introduction

What would happen if China would match North American consumption habits overnight? A popular statement expressing justified worries about the sustainability of Western lifestyles and Western economic growth. The last decade has seen record breaking temperature maxima (Parker et al., 1994; Jones et al., 1999; IPCC, 2001), unparalleled atmosphere CO₂ levels (Song, 2006), and some of the most devastating hurricanes in centuries (IPCC, 2001). Luckily, things are getting better. Greening and sustainability are the buzz words of the 21st century. Nuclear energy is revisited in many places. The Dutch no longer have a monopoly on harnessing wind energy for production means. The rapidly growing economies of the BRIC countries (Brazil, India and China) and the Asian Tigers are spending considerable time and money on greening and sustainability. The Chinese are said to be employing a strategy of “pollute first, clean up later”. Obviously, the West has followed exactly the same development pattern. In the 1950’s when the Western industry was booming, adverse effects of pollution were not yet known. It is often said that we should try to make the underdeveloped countries in “leapfrog” over the polluting stages of industrial development (Chen, 2004). Unfortunately, that is virtually impossible for a variety of reasons. The challenge for the West is making knowledge about sustainable growth and the technology to attain it available to countries on the verge of industrialization. This way, the cleaning up will start significantly earlier than it did in the West and in China. The hypothesis that will be tested in this paper is that for a country to realize there is a need for pollution mitigation, a certain threshold of development must first be reached. This makes “pollute first, clean up later” an unavoidable development pathway.

In this paper, there will be frequent mention of the terms “Western World” and “industrialization”. It is important to note that the former is intended to signify countries with similar development situations while the latter highlights “modernization theory” with regard to the former that besides Europe and the USA, also includes Australia, New Zealand and Japan (the Asian Tigers² are named separately because they developed significantly later than the Western countries). The Western industrialization pathway is explained historically by “modernization theory” which encourages massive production (and consumption) through high technological use and improvement in organizational management. Although the theory has been explicitly used as guides for emerging economies (such as China; see: Qian, 2009), given the importance of the pollution alarms as regarded in this paper, our notion goes beyond modernization and somewhat touches “post-modernization”. In other words, the industrialization pathway of emerging economies encourages massive production while does not neglect the ‘pollution’ impacts, but suggests that the ‘clean up’ stage might be postponed by a tremendous economic growth.

In the first part of this contribution, a summary of the most important views on global warming is given. The widespread belief that pollution at its current rate will produce catastrophic climate change is challenged by substantial criticism. CO₂ emission is projected to cause major global temperature rises. This global warming effect is thought to subsequently cause more acute drought in dry areas, higher intensity of rainfall in wet areas, higher hurricane frequency and even a new ice age as a result of catastrophic

² Here limited to Hong Kong, Singapore, South Korea and Taiwan. Some authors include Japan as well. However, since Japan developed decades before the other Tigers, from an economical point of view, it might be better qualified as a Western country.

changes in hot and cold gulf streams. The scientific basis for these apocalyptic projections is questionable. The models using predictions are biased to special measurements and may neglect some other important parameters which we may not even know because the climate is such a complex system. Moreover, the models are often based on questionable presumptions that have not been proved truthfully. Skeptics face similar problems in making their points. The main problem is that large scale pollution is such a recent challenge, that the amount of available data is simply not sufficient to make any definite judgments and claims about links between pollution and global warming.

The above-mentioned argument will be followed by the link between education and development. Does development result from education? Or does it precede education? We will discuss that development and education are intertwined and follow a predictable pattern in selected historic cases. Generally, a more intelligent population that results from a well developed education system has strong effects on society. It significantly encourages the population to read newspapers and watch the news. Nationwide distribution of information on every conceivable subject is no longer a problem. The government and/or NGOs can use this information network to teach society about the adverse effects of pollution. The process of cleaning up can then begin. Finally, it is stressed that limitless pollution is not promoted here. The West has a responsibility to set the example for developing countries. Only then cleaning up can be fast and growth can be sustained.

2. Believers and skeptics on pollution forced global warming

From a political point of view, the theory of anthropogenic global warming has prevailed over the skeptics. One of the publically well known events showing this is the public's

90 reaction after the release of Al Gore's "An Inconvenient Truth" (2006) and Martin
91 Durkin's "The Great Global Warming Swindle" (2007). The first was met with
92 worldwide praise while the second was surrounded with controversy. As in every
93 politically sensitive debate, information is often being misrepresented on both sides,
94 research is manipulated and the significance of data is being grossly exaggerated. Various
95 studies have proved that we are in fact breaking temperature records and that
96 atmosphere's CO₂ has been steeply rising since mid 20th century. However it has also
97 been shown that climate prediction models do not hold in the face of reality and that the
98 apocalyptic predictions of climate change activists are out of proportion. In this section,
99 an attempt is made to filter science out of the political fog. The most important arguments
100 pro and con anthropogenic global warming are summarized, as this is an important basis
101 to understand the argument to promote CO₂ emission in developing countries.

102 Since the start of temperature data registration in 1880, the global earth surface air
103 temperature has risen by ~0.6°C (Parker et al., 1994; Jones et al., 1999; IPCC, 2001).
104 Estimations from ice core data suggest that average global CO₂ concentrations have
105 always been below 300ppm before 1880. Direct measurements since the late 1950's
106 shows that in the 20th century, CO₂ concentration has dramatically increased from
107 315ppm in 1958 to 375ppm in 2004 (Song, 2006). There is no doubt that this recent rise
108 in CO₂ concentration is being caused by human interventions mainly the industrial use of
109 fossil fuels. It is also unquestionable that increasing the concentration of a known
110 greenhouse gas by 25 percent in a 100 year time span is undesirable and will most likely
111 have an effect on the earth's climate.

112 According to climate specialists at IPCC the icecaps at the North Pole have shrunk
113 considerably and various glaciers have melted. In recent years, we have seen an increase
114 of drought in dry zones and an increase of precipitation in wet areas. Record breaking
115 annual hurricane rates have been reached in recent years. These are mostly paraphrased
116 excerpts from the IPCC report 2001. While the IPCC reports are backed by an impressive
117 amount of well known scientists, it is sometimes hard to find out where their data is
118 coming from. Moreover, some studies have for example shown a dramatic increase in
119 hurricane prevalence between 1988 and 1989 (Asimov and Pohl, 1993), while failing to
120 take into account that hurricane prevalence has fallen back to historically very low rates
121 after that two-year period. B. Lomborg has pointed out an impressive amount of this type
122 of scientific errors and exaggerations - including the aforementioned example on
123 hurricanes - in his 2001 book titled "The Skeptical Environmentalist". Lomborg refers to
124 the widespread belief that humans are the worst thing that has ever happened to the planet
125 as "The Litany". It has been – and still is - repeated so many times that people start taking
126 it for granted, enabling scientists to make claims such as:

127 Intensity of precipitation events is projected to increase, particularly in tropical and high
128 latitude areas that experience increases in mean precipitation. Even in areas where mean
129 precipitation decreases (most subtropical and mid-latitude regions), precipitation intensity is
130 projected to increase but there would be longer periods between rainfall events. There is a
131 tendency for drying of the mid-continental areas during summer, indicating a greater risk of
132 droughts in those regions. Precipitation extremes increase more than does the mean in most
133 tropical and mid- and high-latitude areas. (IPCC, 2007; Chapter 10, p4)

135 This is just one example. The IPCC reports are characterized by intricate causality claims
136 and projections without any reference to research data or even academic literature
137 proving them. However, few people notice this because in current Western society these
138 apocalyptic claims are so often repeated that they seem undisputable.

139 Predictions for future climate change and the implications this has for life on earth are
140 based on complicated mathematical climate models. The climate is so complex however,
141 that the models are far from complete. This is recognized by the people using them, but it
142 is argued that the models are *complete enough* to predict the direction and overall
143 magnitude of climate change in the future. In this respect it is interesting to note that the
144 bursting of the US housing bubble resulted in the global financial crisis of 2007 – 2009
145 largely because asset pricing based on mathematical models turned out to be completely
146 detached from reality.

147 The environmental activists' argument can always fall back to in the face of scientific
148 criticism saying the "better safe than sorry". This seems the only completely waterproof
149 argument promoting mitigation. It combats the fact that the 50 years of reliable direct
150 CO2 concentration measurement is simply not enough to know what percentage of the
151 concentration rise is anthropogenic or what affects a higher CO2 concentration will have
152 on the world around us. However, industry looks and smells bad, it is known to emit CO2,
153 and it is a fact that atmosphere CO2 concentration is rapidly rising. It is therefore a good
154 idea to mitigate pollution until the consequences are better understood *just in case* they
155 do turn out to be as apocalyptic as environmentalists claim.

156 Global warming critics primarily aim at exposing vulnerabilities in the scientific basis
157 behind pollution forced global warming. They have been fairly successful in finding them,

158 but have difficulty in gaining political acceptance for their views. The critics point out
159 that it has not been possible to link the rise in CO₂ concentration to the temperature rise.
160 From ice core data, it is possible to show temperature following CO₂ concentration. It is
161 however, equally possible to show CO₂ concentration following temperature.
162 Furthermore, critics argue that while a portion of the rising global temperature can
163 probably be attributed to human action, it is highly likely that we are presently in a period
164 of natural global warming as well. Some writers have used various methods of statistical
165 curve fitting to make data fit their hypotheses stating a causal relationship between CO₂
166 and temperature (Gilliland, 1982; Hansen et al., 1981).

167 The notion that climate change is an undesirable thing can also be disputed. As a result of
168 global warming, the climate is projected to become warmer and wetter (IPCC, 2007), in
169 effect creating conditions far better suited to general life on earth. The hot and humid rain
170 forests of South America and Southeast Asia have a far larger variation of animal species
171 than the colder parts of Europe for example. NGOs however, tend to focus on individual
172 animals, preferably with high attractive qualities in the public's eyes. A strong case could
173 be made to argue that the Giant Panda is so unfit for its environment that it should have
174 been extinct for decades. Does the cute way a penguin walks or the fearful facial
175 expression of a drowning polar bear make climate change a terrible crime? It certainly
176 helps to make people believe so. This line of reasoning is a key in the main opposition for
177 the "better safe than sorry" argument. This is what could be respected as "nature always
178 finds its way" argument. Species rise and fall by nature. Even if temperature rises by 10
179 full degrees it is unlikely that life on earth will be unable to adapt. It is hard to predict
180 what such a world would look like, and it is questionable if we should desire to pursue it.

181 Additionally, it is simply a delusion of grandeur to think that we, as humans, have the
182 power to destroy the earth by burning some coal.

183 Critics have further argued that in the period between 1945 and 1975, global temperature
184 was decreasing rather than increasing, causing some of the first environmental scientists
185 to warn against the dawning of a new ice-age. This cooling has later been contributed to
186 the increased prevalence of clouds caused by emission of sulphate aerosols (Plambeck et
187 al., 1997). Skeptics have furthermore tried to make a case based on the idea that global
188 warming is not forced by CO₂ emission but by solar activity variation. However, “while
189 many positive correlations between solar variations and climate changes are impressive,
190 this subject remains controversial because they switched in some cases abruptly to
191 anticorrelations.” (Bucha, 1991; p. 2).

192 In sum, most scientific researchers either presume that CO₂ is causing global warming,
193 or focus on trying to prove these researchers are wrong. The first can simply not be
194 proved at this point and the latter lacks constructive conclusions.

195 There is one more interesting take on CO₂ effects from research on vegetation. The thesis
196 is that the process of photosynthesis has evolved in an atmosphere where CO₂
197 concentration was far higher than today. As a result, most plants operate at suboptimal
198 levels and hence would *benefit* from elevated CO₂ concentration. This has been shown in
199 Dutch potatoes (Wolf and Van Oijen, 2003), wheat (Manderscheid et al., 2003) and
200 cotton (Prior et al., 1994)³. This research is generally ignored by climate reviews.

201 Overall, both temperature and CO₂ concentration show clear rising trends since the start
202 of the 20th century. The assumption that temperature rise is caused by CO₂ elevation is

³ There are also studies showing that elevated CO₂ levels do not have a profound effect on crop yields. The consensus is that CO₂ enrichment favors crop yields anyhow.

203 far to prove by current methods and with available data. This means we have no scientific
204 evidence for the belief that the climate will stop warming if we stop emitting CO₂.
205 Moreover, the door is being firmly held shut against the possibility of positive effects of a
206 warmer climate and CO₂ concentration elevation.

207

208

3. Which came first; education or industrialization?

The developed countries in the west are characterized by a high level of general education. In most of these countries, schooling is even obligatory and entirely paid for by the government up to a certain age. Is this a result of high development, or is it the other way around?

Industrialization in the 19th century was driven by the excess of capital that resulted from technological improvements in agriculture. Farmers grew certain crops for cash to invest in more advanced technology for their farms. To facilitate trade between cities high capacity infrastructure was necessary. This resulted in steam engine technology from ships being implemented in railway transport. With the turn of the century we saw the invention of cars and airplanes. Less than a decade later, both of these inventions were already being mass produced. Factory work was complex and it was a huge advantage if workers were able to read instructional manuals. So, education had become a necessity.

Up to the mid 19th century, Europe and North America were still mostly rural economies. Farmers and craftsmen like carpenters and blacksmiths were mostly home educated. They learned a trade, which was often passed on from father to son. A blacksmith or potato farmer had no use for literacy. When industrialization caught on, with any advancement in technology, work in the factories got more complex. It was quickly realized that workers needed to have some basic education to understand what they were doing. This is pointed out in Chinese development during and after the Cultural Revolution.

China's achievements in basic education, especially before and during the Cultural Revolution, have contributed significantly to her economic growth thereafter. The subsequent expansion of junior, secondary, technical and higher education from 1978 has enabled China

232 largely to meet the rising demand for skills in higher-end manufacturing and service sectors
233 (Little and Green, 2009).

234

235 This quote shows that the need for smarter general public is not limited just to the
236 workforce. The elite badly needed expansion as well. Higher education institutes teaching
237 economics, management and engineering rocketed. It was no longer the doctors and
238 lawyers who made the money but industrial entrepreneurs. In Forbes magazine's list of
239 richest people ever, 14 out of 75 persons included are Americans born between 1830 and
240 1840. All renowned American business schools were founded between 1880 and 1920
241 (Gladwell, 2008).

242 The strong link between education and economic development has already been proved
243 in 1982 (Colclough, 1982). Primary schooling increases labor productivity in rural and in
244 urban sectors.

245 A good example of the link between education and economic development is the
246 situation in Eastern Europe. During the Soviet period, the Soviet Union was considered
247 an important world power. Industrialization was rapid and successful, primarily regarding
248 military products. School enrollment rates followed a rising trend, as in every industrial
249 country. After the fall of the Soviet Union in the 1980's however, school enrollment rates
250 started to fall. In 1985, educational expansion showed clear downward movement in
251 Russia, Slovakia and Hungary (Ganzeboom and Nieuwbeerta, 1999). Poland was the only
252 country studied where education enrollment kept rising. Today, Poland is one of the more
253 developed Eastern European states. Russia, in the mean while, has one of the largest gaps
254 between rich and poor in the world and could be considered to be de-developing in
255 several ways. Education can clearly be a result of economic growth. It can obviously

increase growth as well. In a true answer of the “hen or egg” question; neither development, nor education definitely comes first. Economies evolve more gradually and each results from the other. A general pattern can be seen however. Clearly, a first necessity is a stable political situation. After that, educated elite is needed to force technological innovation and industrialization. As a result of the rapid growth associated with industrial growth, more and more of ever more complicated work becomes available. A significant part of the excess capital resulting from the rapid growth is subsequently invested in educating a blue collar workforce to operate complicated machinery and hold lower and middle management function. Some of these newly educated people will later start their own industries or service sector businesses. Industrial development could be said to jumpstart a virtuous cycle of development, resulting in higher need for education, in turn resulting in more, faster and different development.

As a result, such “educated and rich” societies can not only understand the consequences of their developmental interventions in the environment but also they are now rich enough to take some concrete actions to forbid and close those industries which are processing and creating some outputs against the environment and replace them with some new environmentally-friendly businesses. To make enough empathy with the environment, therefore, they have both the “knowledge” and “capital” which have been resulted from economic growth that may already cause some pollution in the environment.

3.1. Education in developing countries

In Latin America, Africa and most of Asia, education levels were very low after World War II. Colonists had no interest in developing education systems for the native

inhabitants of their colonies (Heinink and Koetsier, 1984). Some native elites were trained to fulfill administrative positions in the colonial country (Szirmai, 2005, p228). These people were educated in the language of the colonial force and curriculums were based on Western education. The mass was however not admitted to any substantial education, other than some practical lessons on how to run their farms. The non-colonized countries such as China and Thailand had little traditional education system after World War II as well. They just completely missed the development bandwagon in the 19th century. This is probably because these countries were never a subject to any serious outside force promoting development. While European countries were fighting each other for as long as we can trace history, China has mostly had a very “introverted” civilization. Europe, and later the USA were in an innovations race since the 1600’s, ultimately resulting in the industrial revolution and mass education of the late 19th and early 20th centuries. A notable case is provided by the Asian Tigers. The Tigers have completely caught up with the Western world, even though their industrial development started as late as the 1960’s. Singapore and Hong Kong are among the most important financial centers in the world (Financial Times, November 3rd, 2009). Since the early 1980’s, capital growth rate in Taiwan has risen from 10% to more than 20% per year (Lin, 2004). Lin also shows that a one percent rise in higher education stock⁴ results in approximately 0.19% increase in real output. In another article Lin states that in 1968, government started a policy in which all youths were obligated to attend nine years of education (Lin, 2003). This was preceded however, by efforts of the Japanese colonial

⁴ The percentage of people who received higher education (junior college, college, university or graduate school).

force in the 1940's to industrialize Taiwan. Again, the same pattern of industrialization, emergence of higher education and subsequent rapid economic development is followed.

3.2. Implications of education for the environmental movement

As thus far discussed, the complicated nature of work in an industrial country requires an educated workforce. The resulting higher general level of education has profound effects on society. The acceleration of development is also a direct effect of education but there are other, more hidden consequences of an educated population. External effects of education are reduced fertility and higher infant health (Lloyd et al., 2000). The most important effect however is the increased general intelligence of society. In the developed world we know that we should try to cut back on pollution because we are taught so in school. Knowledge is passed on, and more importantly, expanded on from generation to generation. When it became clear that industry might have adverse effects on the environment, science directed attention toward proving this hypothesis. This gave rise to the first scientific approaches to environmental science. The cooling of the earth between 1945 and 1975 made scientists fear a new ice age was dawning. In school, we are taught to trust scientists, the news and politicians. If we had not received basic education, we would not even be able to understand the newspapers. That is the situation in most of Africa and large illiterate parts of Asia. People in remote rural areas receive little national news and general knowledge is very low. They are literally decades behind in development. This gives rise to situations such as one in Southwest Iran where some small scale farmers believe pesticides are so inactive currently that they could even dare to drink them! They failed to realize that the chemicals were not inactive, but the pests

became more resistant to them⁵. The point is that basic education is a precondition for people to be able to understand that the pollution has effects on the environment. Otherwise, people are unable to relate to the concept of greening now to guarantee a safe future for their grandchildren. The intrinsic egocentric attitude of all animals prevents this future directed behavior in humans. It is naive to think people in underdeveloped countries would just assume the Western knowledge about adverse effects of fossil fuel use to be true. They will not choose inefficient and expensive energy generation methods over the easy energy provided by fossil fuels. Much has been written about leapfrogging development. China could skip polluting stages of development and leap straight to sustainable forms of energy production (Chen, 2004). China however, has large deposits of coal. Without using this fossil fuel source for industrialization, China would never have been able to grow so quickly in such a short time. As Dutch people say “it is hard to imagine a windmill powering a steel construction factory”. In fact, large scale steel construction is necessary to build a windmill in the first place. Clearly, an educated society is a requirement for gaining widespread support for pollution mitigation. Without education, people are unable to see the need for it. This means that leapfrogging is impossible. A country should go through a polluting stage of development before cleaning up can take place.

4. Some techniques for the “pollute first, clean up later” strategy

As discussed, development seems to follow a predictable path. Industrialization is initiated by investing capital in industry. Once underway, the rapid growth will give rise to an efficient education system. The resulting well-informed society increases growth,

⁵ Personal conversation of the first author with the farmers in Darab (Southwest Iran).

346 and then realizes that its growth might not be sustainable. Consequently, efforts are made
347 to mitigate pollution while sustaining growth. This process has taken more than 100 years
348 for the first industrializing countries in the Western world. The Asian Tigers and China
349 have caught up in less than 50 years⁶. This double speed could be attained because the
350 Tigers and China only had to implement the latest Western technology, while the West
351 first had to invent every part of the process.

352 Pulverized-coal fired power plants, as in use in all developed countries, reach efficiency
353 levels of about 40% (Franco and Diaz, 2009). State of the art ultra-supercritical plants are
354 able to improve the efficiency around 50%. A third technique known as Integrated
355 Gasifier Combined Cycle (IGCC) can operate at efficiency levels of 60%. These
356 technologies can all be combined with modern carbon capture and sequestration (CCS)
357 technology, reducing CO₂ emission to minimal amounts. These are examples of
358 technological advancements to enable the clean use of fossil fuel reserves. The main
359 problem with these technologies is their high costs and high complexity. Both of these
360 problems make them unsuitable for use in newly industrializing countries. They do
361 however clearly show great potential in sustaining development of the emerging BRIC
362 economies. If the Western world succeeds in profitably generating power from coal at
363 60% efficiency and with minimal greenhouse gas emission, the developed world will
364 dramatically reduce pollution, and will have completed their “clean up” process. This will
365 serve as an example for the Asian Tigers and the BRIC countries. A development model
366 could then be created to enable remaining undeveloped countries to catch up even faster
367 than China and the Tigers.

⁶ China only lags behind the Asian Tigers in terms of GDP per capita because of the vast area of the country and the large, poor rural areas where development is still very low.

5. Setting the example, cleaning up the west

The western world is the classical example for the developing world. While we are worried about the environment, African youths are interested in getting coca-cola and blue jeans. The Asian Tigers have modeled their education systems and industrial methods after Western standards. By setting the right example, we can prevent growing economies from making the same mistakes we did. By making technology available to burn coal as efficiently and pollution free as possible, we can help development come in as green a manner as possible.

In the West, efforts to mitigate pollution have widely become accepted. It is evident that greening does not have to cost money. Every company is interested in cutting costs, as lower costs increase profit, and cutting energy expenditure - for instance by replacing light bulbs with LED illumination - is a great way to achieve this. Greening is a public and corporate buzz so every new product with some green quality can easily get popular. For the first time in history, a car's fuel economy and energy label is equally important a decision criterion as the amount of horsepower or top speed. Nevertheless, errors have been made. It is well known for example that it takes significantly more energy to create a Toyota Prius (including the costs of research) than the amount of energy it will save during its lifetime. In a striking 1992 article Robert Dean highlights some of these fads in environmental policy. An interesting point is that burning waste, other than fossil fuel derived waste such as oils and plastics, does not contribute to the greenhouse effect. The reasoning is simple. The carbon contained in wood and wood derivatives such as paper has been drawn out of the atmosphere during the growth of a tree or plant. Whether the product is burned or left to decompose by nature, the carbon will be returned to the

atmosphere a relatively short time after, it has been taken out. So, providing the global forest and green vegetation area is sustained, burning wood or paper is a perfectly green and sustainable way of energy production⁷. The west should strive to make greening more of a means instead of an end in the near future. Constantly, making sure that green initiatives are not costing more energy than they could save. Having said that, it is vital that the West cuts back on their emission levels significantly to sustain the atmosphere quality in the face of increasing emission by developing countries. The US and Europe were responsible for 23.8% of global CO₂ emission in 2007. China has already surpassed the US at 21.5% of global CO₂ emission (International Energy Agency, 2009). The quick development of the Asian Tigers and subsequent rise of the Chinese and Indian economies shows a highly effective development route. One study has shown that Chinese CO₂ emission levels have been doubled in the past five years. Moreover, even by optimistic projections, Chinese emission levels will likely be more than double again in the future (*Guan et al., 2008*). By that time, Chinese per capita emission levels will be close to the American and European's levels. If Africa starts growing in a similar way as Asian countries already have, global pollution levels will certainly reach outrageous levels. Luckily in China, efforts to mitigate pollution have already started. Many researchers, both domestic and foreign, are trying to devise ways of making Chinese growth sustainable. It is eminent that these efforts are encouraged by the West and that as much knowledge as possible is shared.

⁷ Moreover, it is interesting to note a point made against the use of bio degradable plastics. Making plastics biodegradable frees the carbon contained in them to the atmosphere (thus, contributing to the greenhouse effect), while storing traditional inert plastics in a landfill puts the fossil carbon back into the ground where it came from.

411 The task the western countries have in the 21st century is twofold. First, the level at which
412 Western, Asian, Latin American and African pollution levels will ultimately converge
413 can largely be determined by mitigation strategies of the west. The technologically most
414 advanced countries should lead the way to ever greener forms of energy production and
415 waste management. Better use of nuclear energy in Europe for instance, could “free-up”
416 environment for cheap Indian coal installations to pollute (although one could argue that
417 the massive amounts of water vapor emitted by nuclear reactors could also pose a risk for
418 the climate). Nuclear power plants do not emit any CO₂ or chemicals. The radioactive
419 waste can be easily disposed of with current technologies. Nuclear energy has all
420 potential to be a great sustainable power source. The only problem lies in the devastating
421 effects of nuclear weapons. The Western countries, most notably the USA, try to prevent
422 foreign nuclear activity (most recently Iran and North Korea) as much as possible. They
423 fear that nuclear technology would be used to construct weapons against their benefits.
424 This fear is most likely exaggerated. Nuclear war is a classical example of a problem with
425 no technical solution. In analogy with the game ‘tic tac toe’, it is blatantly obvious that
426 there can be no winners in an all out nuclear war.

427 Mitigation of household CO₂ emission levels is important example setting behavior. It is
428 important that we discourage developing countries from attaining the same exorbitant
429 consumption levels we have today. The second task is making knowledge regarding
430 pollution control and greening available to the developing world. We should prevent
431 rising economies from making the same errors in recycling and greening attempts as we
432 have made. Best practices should be shared with the emerging BRIC economies and with

the undeveloped areas in Latin America and Asia as well as with sub-Saharan African countries.

6. Discussion and conclusion

It has become clear that the hypothesis of this paper is true. Polluting industries have preceded greening in all cases. An uneducated population is unable to see why cleaning is necessary to sustain life on earth. Moreover, green alternatives are simply too expensive at this point to be of any use in developing countries. Pollute first, clean up later might at this point be truly unavoidable.

It is possible however, to devise approaches to the sustainable application of this development strategy. As it looks unlikely that industrial CO₂ emission will cause catastrophic climate change, there is no scientific objection against promoting the use of fossil fuels in developing countries. As is evident from the histories of all highly developed countries, the use of high energy fossil fuels is required to approach quick development. It is possible, even likely, that green energy alternatives will eventually be made efficient enough to be economically viable for use in poor countries, but at this point in time, they are too expensive. However, if the clean up process starts soon enough, the continued use of fossil fuels is not a big problem as it is commonly thought.

The success formula for development has been distilled from the development of the Asian Tigers and China. These countries approached the Western levels of development in less than half the time that the West needed for the same development level. The ‘clean up’ process is well underway in those areas, now that the first rapid growth has been realized. Given the proper guidance, the right knowledge and access to state of the art technology, newly developing countries should be able to rush through the pollution

457 stages at breakneck speed, reaching 'clean up' well before any problematic effects of
458 pollution can be expected to materialize. Seems that continuing mitigation strategies in
459 the West will free up environmental space for developing countries to pollute! Therefore,
460 the west should also set the example for developing countries by further reducing their
461 pollution levels.

462 A clear limitation in this paper is the neglect of political factors. China is still a subject to
463 censorship policies and is notorious for its violation of human rights. Also, Singapore
464 may have very high economic development and low poverty while characterized by an
465 abundance of regulation and government control. Political stress is of particularly
466 problematic proportions in sub-Saharan Africa. Political stability is a *must have* before
467 any significant development can take place. Moreover, it is highly preferable to have an
468 educated government. Hyper-inflation in Zimbabwe would not have to get so enormously
469 out of hand if the central bank would have been run by skilled economists for example. It
470 has been shown in China and Singapore that heavy state influence can positively affect
471 development, but ethical problems prevent promotion of these practices.

472 The Islamic world is a case in its own, which has been omitted from this paper. This area
473 is obviously troubled by political instability as well. The OPEC countries may be rich,
474 but some have extreme differences between rich and poor and other disabling problems
475 such as women oppression practices. Iran, as the most emerging and influential economy
476 in the Middle East for example, is also a current hot subject to censorship policies and
477 notorious for its human rights violation. It is clear that political factors are important.
478 They were however not included in the delimitation of this study. If the prerequisite of a
479 stable political situation is met, the theories in this paper can be held.

Finally, some implications for future studies could be perceived as a result of this study. In theory, a critical review could be drawn on this study portraying a historical overview on ‘development economic theories’. Such an overview can scrutinize how novel the hypothesis of this study is and whether it could be discussed in the frame of previously formulated development economic theories or can be considered as a new incubator for the future theories. In practice, a multi-case study could be conducted to tentatively test whether the hypothesis is workable. Such case studies could be held on the bases of both ‘country-case’ (e.g. BRIC countries) and ‘region-case’ (e.g. the Middle East and Southeast Asia).

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